JSES International 7 (2023) 2296–2303

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Position of scapula and clavicle in acute acromioclavicular joint dislocations: depressed scapula or elevated distal clavicle?

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ARTICLE INFO

Keywords:
Acute acromioclavicular joint dislocation
Rockwood classification
Weighted panorama views
Non-weighted panorama views
Coracoclavicular distance
Pseudoelevation of the clavicle
Vertical displacement

Level of evidence: Anatomy Study; Imaging

Background: Increased coracoclavicular distance due to acute acromioclavicular joint (ACJ) instability is often described as a pseudoelevation of the clavicle due to inferior hanging of the scapula, while the distal clavicle remains in its position. The aim of this study was to analyze whether the elevation of the distal clavicle, depression of the scapula, or both are associated with vertical instability and to evaluate the impact of weighted stress radiographs on the clavicle and scapular position in acute ACJ instabilities.
Methods: The cohort consisted of 505 patients (f = 52, m = 453; mean age 46 years) which presented to our emergency department or outpatient clinic and treated in our institution from 2006 to 2019 displaying an acute ACJ injury. The panorama views that displayed at least two vertebraes with their spinous processes were retrospectively evaluated. Two raters assessed the panorama views twice regarding the clavicular and coracoidal angle of both sides in relation to the cervicothoracal spine and the difference in height of both clavicles and coracoids.
Results: In our cohort, five types of displacement were distinguished: type A, only clavicle is elevated (N = 46); B, only scapula depressed (N = 36); C, the clavicle elevated and the scapula depressed (N = 67); D, both depressed (N = 133); and E, both elevated (N = 223). 123 patients had non-weighted radiographs and 353 patients stress views with 10 kg of axial load, whereas 29 patients had both radiological modalities. Among these 29 patients, a significant increase in coracoclavicular distance difference, clavicle, and scapula height ($P < .05$, respectively) was observed, when non-weighted radiographs were compared with weighted. A total of 13 shifts could be observed during the Rockwood type comparison of non-weighted radiographs with the weighted: six from Rockwood type II to III, two from type III to V, and five from type V to type III.
Conclusion: Acute injury to the ACJ does not exclusively lead to a depression of the scapula or an elevated distal clavicle but rather leads to various vertical displacement combinations, however mostly to the elevation of both structures possibly due to muscle spasm and pain. Comparing both radiological modalities of the same patients, the routine use of weighted views should be questioned, since often a shift of Rockwood stage can be observed might lead to on the one hand inadequate conservative treatment for underestimated injuries however on the other hand unnecessary surgery for overestimated dislocations.

Acromioclavicular joint (ACJ) injuries are common causing about 12% of shoulder girdle injuries in the general population[25] and nearly half of all shoulder injuries among athletes involved in contact sports.[1,7,11] Direct or indirect mechanical trauma to the ACJ causes rupture of the ligament complexes between the acromion, the clavicle, and the coracoid process with possible subsequent instability.[15] The correct classification of the injury severity based on the degree of vertical and horizontal stability is essential in deciding the suitable treatment option.[27] Although newer studies are focusing on dynamic instability in the horizontal plane,[8,16,21] Rockwood classified the vertical instability based on the comparative examination of panorama radiographs and evaluation of vertical displacement with the help of the coracoclavicular distance (CCD) relative to the uninjured side.[27] Furthermore, numerous studies proposed the addition of weighted stress radiographs to aid

This study was reviewed and approved by the institutional review board of Charité Universitätsmedizin (Application number: EA1/298/12).
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https://doi.org/10.1016/j.jseint.2023.06.011

in treatment recommendations.[2,4,20] However, the evidence regarding weighted radiographs is controversial, since only two limited previous studies with contradictory conclusions are available.[5,9] Bossart et al[5] indicated that only a small amount of weighted views showed a Rockwood III injury, which were not evident on non-weight bearing radiographs, whereas Ibrahim et al[8] demonstrated that stress views provide additional information helping to guide the management of ACJ injuries because of its ability to uncover Rockwood V injuries.

Radiologically increased CCD appears clinically as the typical elevation of the injured distal clavicle. However, some studies describe this phenomenon as a pseudoelevation of the clavicle due to inferior hanging of the scapula because of the loss of the bony bridge to the thorax, while the distal clavicle remains in its position.[15] In addition, the impact of weighted stress radiographs on this phenomenon is unknown and might understate or overstate the Rockwood stage possibly leading to unnecessary surgical treatment. The aim of this study was therefore to analyze whether the elevation of the distal clavicle, depression of the scapula, or both are associated with vertical instability and to evaluate the impact of panorama weighted stress radiographs on the clavicle and scapular position in acute ACJ instabilities. We hypothesized that vertical elevation of the distal clavicle and depression of the scapula occur in ACJ dislocation. Furthermore, we assumed that weighted radiographs might overestimate the Rockwood type.

Methods

Study cohort

Approval from the institutional ethics committee was obtained prior to the onset of this retrospective investigation (EA1/298/12). All consecutive patients with an acute ACJ injury ($\leq$ 3 weeks), who were treated in our institution from 2006 to 2019 and had panorama views with both ACJs, were included. Weighted views with or without thyroid led protection in the emergency department and outpatient clinic at our institution are obtained in a standardized fashion with the patients standing, their scapulae supported against a vertical surface, their feet shoulder width apart and holding 10 kg weights in each hand. The same standard without holding 10 kg weights is used for non-weighted panorama views. A total of 598 patients were available for the radiological assessment. The included panorama views contained at least two vertebrae with their spinous processes displayed, since the spinous processes were used as reference points to determine the vertical body axis for further measurements. Radiographs with only one spinous processes or without any at all (n = 23) and with a history of previous injury, spinal deformity, or surgery altering the ACJ (n = 6) were excluded. Moreover, some old radiographs that could not be uploaded to radiological software (Visage Imaging) (n = 64) were also not able to be used for further radiological measurements. In total, from 598 patients, 93 of them were excluded as depicted in Fig. 1.

Radiographic measurements

Panorama views of the shoulder girdles in the upright position prior to the conservative treatment or surgery were utilized for the radiological evaluation. They were retrospectively evaluated regarding the clavicular and scapular position of both sides in relation to the vertical body axis and the difference in height of both clavicles and coracoids. All radiological measurements were carried out digitally using Visage software (version 7.1; Visage Imaging, Berlin, Germany).

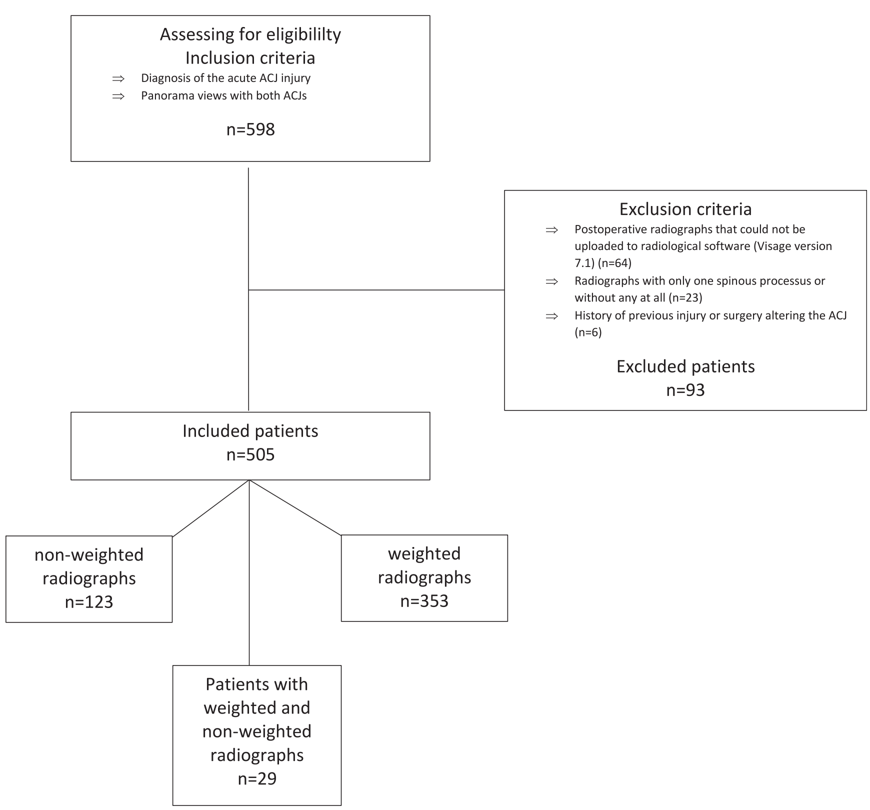

Figure 1 Flow diagram of the study participants. *ACJ*, acromioclavicular joint.

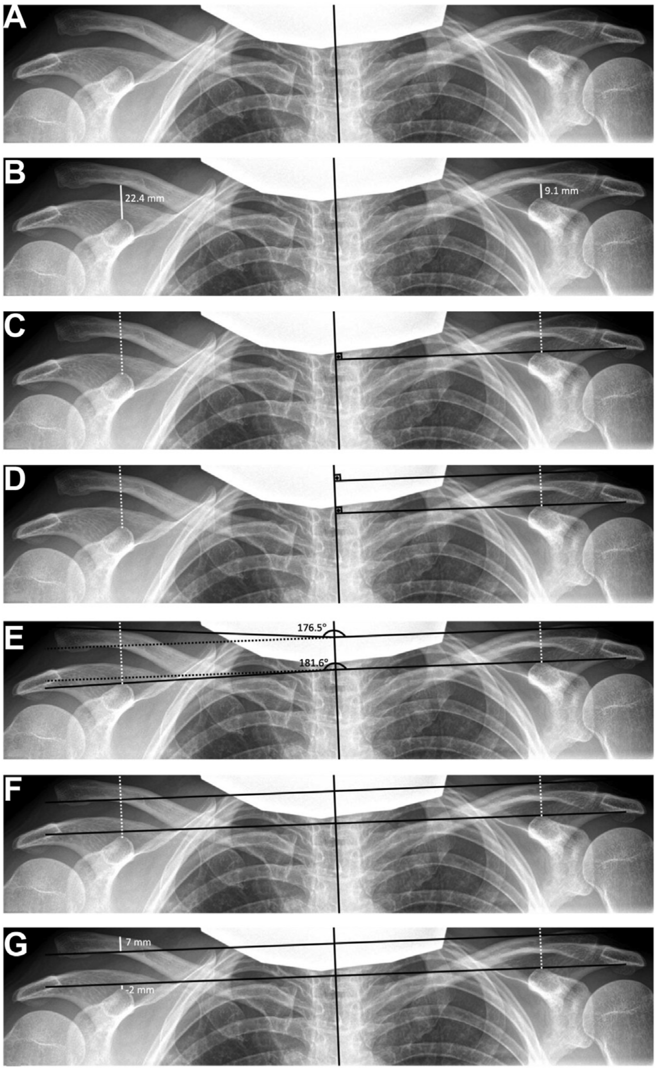

Figure 2 (**A-G**) Standardized radiological measurement (mm) in a patient with a Rockwood type V injury of the right ACJ (type C according to our classification). Panorama views of the shoulder with a 10 kg axial load on both sights (weighted). *ACJ*, acromioclavicular joint.

CC distance and Rockwood classification

For the purpose of standardizing all measurements, the spinous processes of the displayed vertebrae were connected with a vertical line (Fig. 2*A*). Parallel to this line, the distance between the coracoid process (superior cortex) and the clavicle (inferior cortex) was measured on the healthy and injured side (Fig. 2*B*). Following the CCD measurement on both sides, Δ*CCD* was calculated as the percentage increase of the CCD of the injured side as compared with the healthy side, Δ*CCD* (%) = [(injured side /healthy side) *x* 100] – 100. The measured Δ*CCD* was utilized to determine the appropriate Rockwood classification[27] for the injury. The Δ*CCD* is in Rockwood type I below 10%, in type II 10-25%, in type III 25-100%, and in type V more than 100%.[27]

Position determination of the clavicle and shoulder girdle

Following the CCD measurement, the positions of the clavicle and scapula were determined with the help of angle and height measurements on a side comparative manner. Two horizontal lines (orthogonal to the vertical line) were drawn touching the highest point of the coracoid process (Fig. 2*C*) on the healthy side and to the point where the extension of the line for the previous CCD measurement intersects with the upper cortex of the lateral end of the clavicle on the healthy side (Fig. 2*D*). The same lines were depicted on the injured side analogously to the healthy side and measured angles were documented (Fig. 2*E*). If the measured angle was greater than 180°, there was a depression of the clavicle/scapula, whereas an obtuse angle meant an elevation of the clavicle/scapula. Afterward, the horizontal lines of the uninjured side were extended to the injured side (Fig. 2*F*) and the distances were calculated between the extended horizontal lines and the highest point of the coracoid process and with the upper cortex of the lateral end of the clavicle (Fig. 2*G*). When the reference points were above the lines of the protractors, the measured distances were positive and when they were under the lines, the calculated results were documented as negative distances. Following the distance measurements, patients were classified according to the five types that we proposed: in type A, only clavicle is elevated (Fig. 3*A*); in type B, only scapula depressed (Fig. 3*B*); in type C, the clavicle elevated and the scapula depressed (Fig. 3*C*); in type D, both depressed (Fig. 3*D*); and in type E, both elevated (Fig. 3*E*).

Statistics

For the purpose of determining interobserver and intraobserver reliability first consecutive 99 patients were measured twice by two raters (A.P. and M.M.) for the purpose of determining interobserver and intraobserver reliability. Both raters performed the measurements independently and at different time points. Intraclass correlation coefficients (ICCs) with a 95% confidence interval were calculated for all measurements. As recommended by Landis and Koch, an ICC < 0.20 resembles slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and >0.81 almost perfect agreement.[14] After reliability assessment, the values of both raters were averaged for further analysis. The Kolmogorov-Smirnov test was used to test for normal distribution. The two-sample *t*-test (for parametric distribution) or Mann-Whitney U test (for nonparametric distribution) was used to compare continuous variables between groups. The results were given as the mean and the standard deviation or as the number and percentage. For statistical analysis, IBM SPSS Statistics 25.0 software (IBM, Armonk, NY, USA) was employed. A *P* value < .05 was considered significant.

Results

According to ICC calculations, every measurement taken was in almost perfect agreement. A mean intrarater reliability ICC_{mean} of 0.92 was calculated for the rater A.P. and an ICC_{mean} of 0.89 for the rater M.M. The ICC_{mean} for interrater reliability had a value of 0.86.

The final study cohort consisted of 505 patients (52 females, 453 males; mean age 46 years). 123 patients had standard nonweighted radiographs and 353 patients stress views with 10 kg of axial load, whereas 29 patients had not only weighted but also nonweighted radiographs (Fig. 1). In order not to evaluate the same patients twice, we only considered weighted radiographs of these 29 patients for the description of our final cohort with 505 patients. There were 14 type I (3 females, 11 males; mean age 36 years), 24 type II (5 females, 19 males; mean age 41 years), 181 type III (20 females, 161 males; mean age 43 years), and 286 type V (24 females, 262 males; mean age 48 years) injuries according to Rockwood (Table I). Patients with Rockwood III and V formed 92.4% of the overall collective.

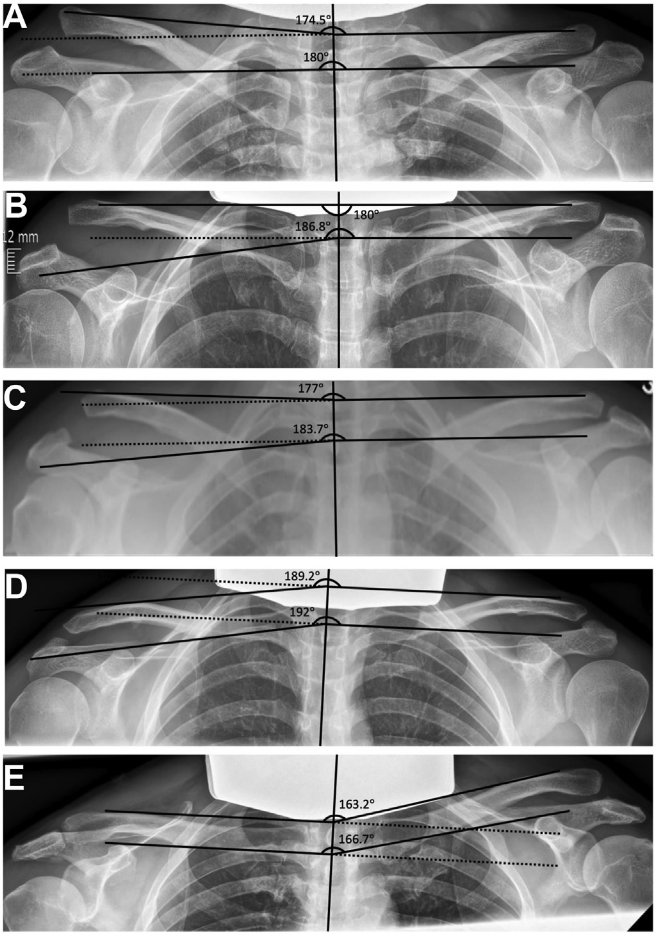

Figure 3 (**A-E**) Measurement examples for each type (**A**: only clavicle is elevated, **B**: only scapula depressed, **C**: the clavicle elevated and the scapula depressed, **D**: both depressed, **E**: both elevated).

According to our radiological measurements, the most common type was E overall (44.2%), meaning the elevation of scapula and distal clavicle, respectively (Fig. 4). Moreover, in all Rockwood types except Rockwood I, type E according to our classification was the most common (among Rockwood type II: 41.7%, type III: 45.3%, and type V: 44.8%), whereas in Rockwood I, type D was leading (Rockwood type I: 64.4%) (Fig. 5). The percentage of weighted views did not differ significantly from each other among the types according to our classification: Approximately three-quarters of the patients had weighted views (A: 78.3%, B: 75.0%, C: 74.6%, D: 78.2%, E: 74.0%).

All radiological measurements except the CCD on the uninjured side differed in their values significantly, when they were grouped according to our classification (Table II). In parallel with the expectations related to our classification, CCD was the highest in type C (13.0 mm). Since the scapula is depressed in types B-D, mean reflex angle and mean depression of the scapula were observed in those types (B: −11.3 mm and 184.6°; C: −8.2 mm and 183.2°; D: −19.2 mm and 187.5°), which significantly differed from the vertical placement of the scapula at 180° in type A and elevation of the scapula in type E (14.7 mm and 174.4°). The clavicle is elevated in types A, C, and E, which is why a mean obtuse angle and mean elevation of the clavicle were seen among these types (A: 10.4 mm and 176.0°; C: 7.0 mm and 177.7°; E: 14.7 mm and 170.6°), from which the horizontal placement of the clavicle at 180° in type B and the depression of the clavicle in type D differed significantly, respectively (B: 0.1 mm and 180.0°; D: −10.8 mm and 184.2°).

In the final cohort, 75.6% of the radiographs (382 out of 505) were weighted. Table III depicts the radiological measurements of the cohort depending on weighted or non-weighted views. Except the CCD in percentage, no significant difference could be observed in the radiological measurements of the entire cohort. Only 29 patients (3 females, 26 males; mean age 42 years) out of 505 patients had weighted as well as non-weighted radiographs. Table IV summarizes their radiological measurements depending on non-weighted or weighted views. In this subcohort, the clavicle was significantly elevated among weighted radiographs (weighted: 10.1 mm vs. non-weighted: 2.2 mm; $P < .001$), whereas a significant depression of scapula was seen in non-weighted radiographs (non-weighted: −4.1 mm vs. weighted: +2.3 mm; $P = .002$). Moreover, a significant CCD difference between weighted and non-weighted views could be demonstrated (weighted: 8.4 mm vs. non-weighted: 6.9 mm; $P = .008$).

Table V summarizes the change of Rockwood and our classification depending on non-weighted or weighted views. The analysis of non-weight bearing views followed by the analogous analysis of weight bearing views showed that the most common type shifted from type D to type E. In total, 11 type shifts occurred, when non-weighted radiographs were compared with weighted: three shifts from type A to type E happened and two from D to E, whereas two shifts to type D were seen from type A and B, respectively. Clearly, Rockwood type III was leading among the weighted radiographs, whereas Rockwood type III and V were the most common type among the non-weighted views. A total of 13 shifts could be observed during the Rockwood type comparison of non-weighted radiographs with the weighted views: Six shifts occurred from Rockwood type II to III and two shifts from type III to V, whereas five shifts from type V to type III were present.

Discussion

We analyzed in our study, whether the position of the distal clavicle and the scapula is associated with vertical instability and evaluated the impact of weighted stress radiographs on the clavicle and scapular position in acute ACJ instabilities. In the cohort of 505 patients, regardless of radiological imaging modality (weighted or non-weighted), an elevation of scapula and distal clavicle together (type E) was most commonly found (weighted: 43.2%, non-weighted: 47.2%). Interestingly, the second most common measured type was type D, meaning depression of the clavicle and the scapula (weighted: 27.2%; non-weighted: 23.6%). In contrast to our data, Azar et al[3] found that only the elevation of the clavicle occurs (analogous to our type A) and causes the vertical displacement in weighted and non-weighted views of patients with Rockwood III or V injuries. In our cohort, only 9.2% of all Rockwood type III injuries with weighted and non-weighted views and Rockwood type V injuries with weighted radiographs had an elevated distal clavicle with scapula remaining in its position (type A: 36/391). Patients with clavicle and scapula elevated were the most common type with 44.8% among this selected subcohort (type E: 175/391).

Our results contradicted with the assumption that vertical dislocation is a “pseudoelevation” of the clavicle with concomitant scapula depression of the injured side.[13,15,25] A possible explanation for the elevation of the distal clavicle can be found analogous to the mechanisms described in a clavicle fracture[3]: In the event of a clavicle fracture, the sternocleidomastoid muscle[23] or the descending part of the trapezius muscle[26,28] or both dislocates the lateral fragment of the clavicle upward. However, this does not clarify the elevation of the scapula. This aspect can be elucidated by potential pain-triggered muscle activity mainly by the descending

Table I
Radiological measurements of 505 patients grouped and compared according to Rockwood classification.

Measurement									
Type	Total n	CCD IS (mm)	CCD HS (mm)	CCD difference (mm)	ΔCCD (%)	Cla-angle (°)	Cor-angle (°)	ΔCla (mm)	ΔCor (mm)
I	14	11.2 ± 1.6	10.6 ± 1.5	0.7 ± 0.3	6.0 ± 2.8	183.0 ± 4.7	183.2 ± 4.6	−7.8 ± 11.9	−7.9 ± 11.5
II	24	20.0 ± 2.7	8.9 ± 1.9	1.6 ± 0.5	18.0 ± 4.2	178.7 ± 6.3	179.6 ± 6.3	2.8 ± 15.2	0.9 ± 15.2
III	181	17.1 ± 4.7	10.3 ± 2.4	6.9 ± 2.9	67.0 ± 22.0	177.0 ± 6.4	180.0 ± 6.7	7.7 ± 16.5	0.7 ± 17.5
V	286	21.3 ± 5.1	8.0 ± 2.3	13.3 ± 3.9	179.0 ± 76.8	175.2 ± 6.3	180.3 ± 6.4	12.1 ± 16.1	−0.8 ± 16.3

CCD, coracoclavicular distance; *IS*, injured side; *HS*, healthy side; *Cla*, clavicle; *Cor*, coracoid.

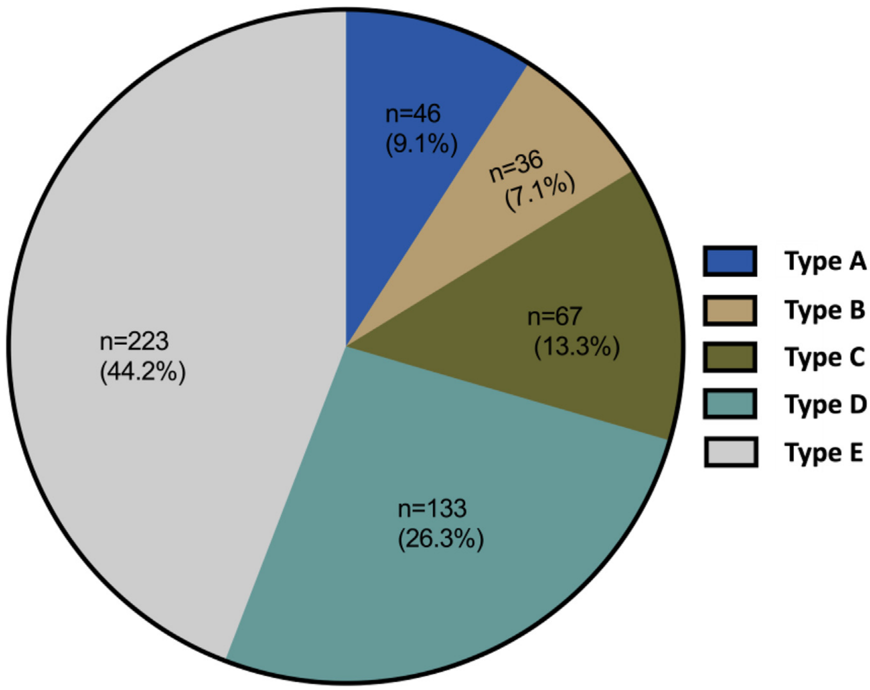

Figure 4 Pie chart depicting the distribution of types A-E in the entire cohort.

part of the trapezius muscle and elevation of the shoulder girdle. The second most common type in our study was type D, meaning depression of the distal clavicle and the scapula, respectively, which is contravening with the pseudoelevation theory as well. A possible explanation for the depression of both structures may root in the functional understanding of thoracoscapular joint anatomy so that an impaired ACJ stability could result in depression especially of the scapula due to the force direction of gravity and secondary also of the clavicle in the relaxed muscle state.

For decades, weighted panoramic radiographs for the classification of ACJ dislocations have been favored and are still in current clinical practice.[2,12,17,20,27] Several authors suggested that pain-triggered muscle spasm may mask the total extent of an injury, resulting in misdiagnosis as a lower-grade injury, which would make weighted films necessary to distract the ACJ.[2,9,20] Bossart et al[5] found that in only 3 of 84 cases (4%) weighted views showed a Rockwood III injury not evident on non-weight bearing radiographs. They indicated that the CCD of both the injured and healthy side could be affected by adding weights and that it sometimes paradoxically narrowed in the stress views. Additionally, Nordin et al[18] in a similar study measured CCDs of a larger group containing 140 patients, who each had bilateral weighted, non-weighted, and internal rotation radiographs, and also found no evidence supporting the use of weighted or internal rotation radiographs in the classification of ACJ dislocations. However, Izadpanah et al and Ibrahim et al conducted studies demonstrating that stress views provide additional information helping to guide management of ACJ injuries.[9,10] Ibrahim et al's[9] study reported 10 out of 59 patient diagnoses increased to Rockwood V injuries when weighted views were used, suggesting weight-bearing radiological imaging may be useful because of its ability to uncover Rockwood V injuries. This was further supported by Izadpanah et al[10] using a magnetic resonance imaging of the shoulder at rest and under 6.5 kg shoulder traction. In all 10 cases reported, a precise outline of the coracoclavicular ligaments and a differentiation between sprained and torn ligaments could be obtained, indicating stress magnetic resonance imaging provides a significant diagnostic advantage. Both studies came to the conclusion that a significant increase in the CCD was to be seen when weights were applied, sometimes resulting in an upgrading of Rockwood III injuries.

The results of our small cohort with 29 patients, who each had weighted and non-weighted views, brought out the following observations. A significant increase of mean CCD in weighted versus non-weighted views ($P = .008$) was observed, which was in parallel with Izadpanah et al's and Ibrahim et al's reveals.[9,10] In comparison to the conclusions of both studies, we observed changes in injury classification in both directions, when non-weighted radiographs were compared with weighted. In total, 13 Rockwood classification shifts occurred during the comparison of non-weighted radiographs with the weighted views: While six upgrades occurred from

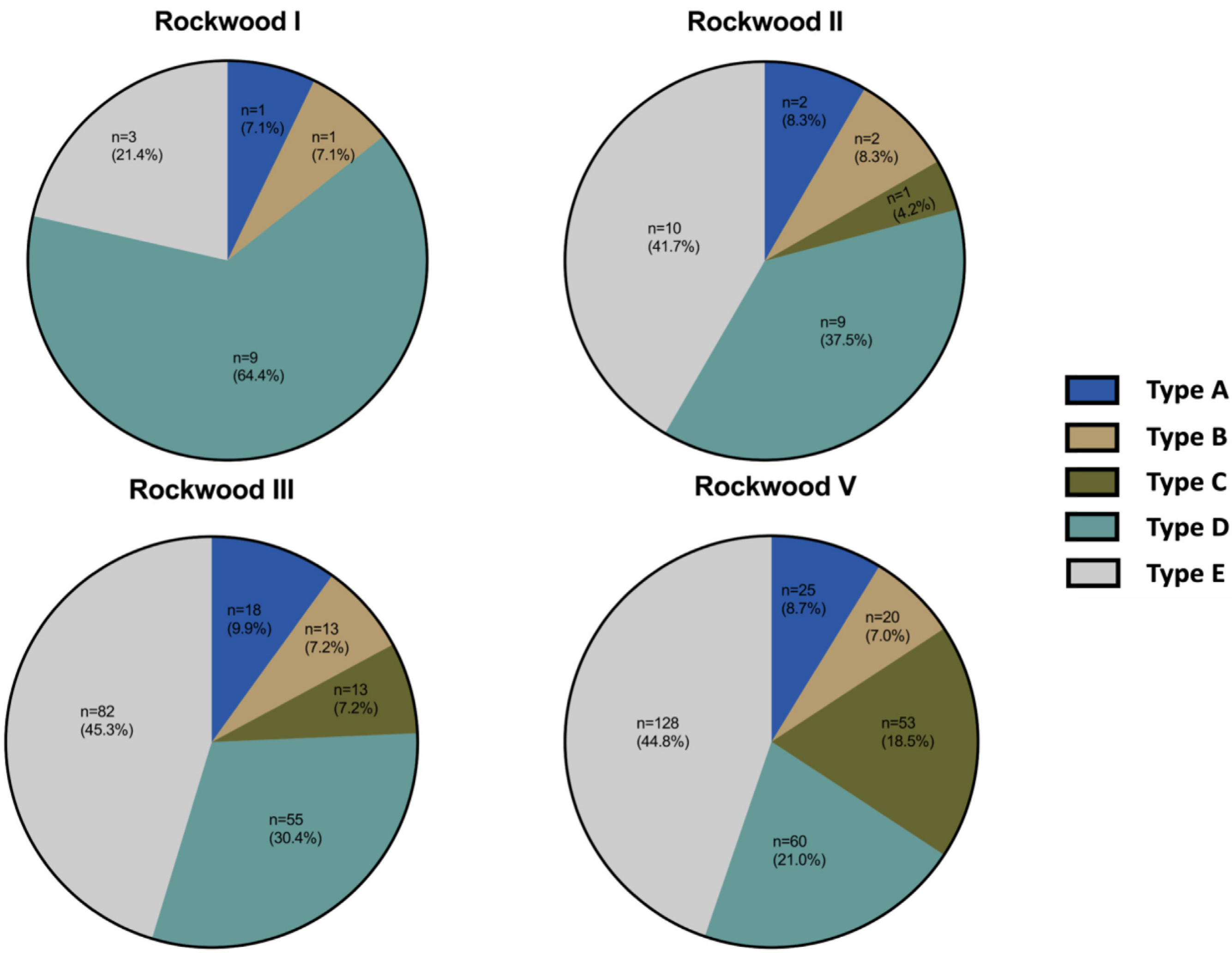

Figure 5 Pie charts depicting the distribution of types A-E among the Rockwood groups.

Table II
Radiological measurements of 505 patients grouped and compared according to our classification.

Measurement									
Type	Total n	CCD IS (mm)	CCD HS (mm)	CCD difference (mm)	ΔCCD (%)	Cla-angle (°)	Cor-angle (°)	ΔCla (mm)	ΔCor (mm)
A	46	19.0 ± 4.7	9.3 ± 2.7	9.7 ± 4.5	115.3 ± 66.9	176.0 ± 2.0	179.7 ± 0.8	10.4 ± 4.7	0.4 ± 1.8
B	36	20.0 ± 5.5	9.2 ± 2.2	10.8 ± 5.4	127.2 ± 75.1	180.0 ± 0.8	184.6 ± 6.4	0.1 ± 1.6	−11.3 ± 5.4
C	67	22.1 ± 5.4	9.1 ± 2.4	13.0 ± 4.6	152.5 ± 70.7	177.7 ± 2.4	183.2 ± 2.4	7.0 ± 4.3	−8.2 ± 5.3
D	133	17.4 ± 5.3	8.9 ± 2.6	8.5 ± 4.9	111.3 ± 88.8	184.2 ± 2.8	187.5 ± 3.2	−10.8 ± 7.3	−19.2 ± 8.5
E	223	18.9 ± 5.8	8.7 ± 2.5	10.1 ± 5.2	129.4 ± 91.1	170.6 ± 4.1	174.4 ± 3.7	23.8 ± 10.4	14.7 ± 9.5

CCD, coracoclavicular distance; *IS*, injured side; *HS*, healthy side; *Cla*, clavicle; *Cor*, coracoid.

Rockwood type II to III and two from type III to V, five downgrades happened from type V to III. In conclusion, a significant increase in the CCD was to be seen when weights were applied, sometimes resulting in an upgrade or downgrade of Rockwood injuries. These, according to our results, unpredictable changes in classification might lead, on the one hand to inadequate conservative treatment for underestimated injuries however, on the other hand to unnecessary surgery for overestimated dislocations. In acute clinical setting, the weighted radiographs should be utilized less and adequate pain management is important due to pain-triggered muscle activity.

Taking radiation exposure considerations into account, the routine use of panorama views can be questioned despite the increased diagnostic accuracy with bilateral evaluation of both ACJs. Currently, a standardized protocol to image acute ACJ injuries does not exist, rendering proficient and unanimous diagnosis difficult.[19] Today, in acute trauma setting, panorama views provide a reference for the normal articular configuration and the CCDs,

Table III
Radiological measurements of 505 patients depending on non-weighted or weighted views.

w vs. nw				
Measurement	Weighted	Non-weighted	Overall	*P* value
Total n	382	123	505	-
CCD IS (mm)	18.9 ± 5.7	19.4 ± 5.5	19.0 ± 5.7	.415
CCD HS (mm)	9.0 ± 2.5	8.6 ± 2.6	8.9 ± 2.5	.124
CCD difference (mm)	9.9 ± 5.2	10.7 ± 5.1	10.1 ± 5.2	.100
ΔCCD (%)	121.8 ± 83.3	140.3 ± 91.5	126.3 ± 85.6	.037
Cla-angle (°)	176.3 ± 6.6	176.2 ± 6.3	176.3 ± 6.5	.877
Cor-angle (°)	180.2 ± 6.6	180.3 ± 6.1	180.2 ± 6.5	.827
ΔCla (mm)	9.3 ± 16.8	10.1 ± 15.5	9.5 ± 16.5	.643
ΔCor (mm)	−0.3 ± 16.9	−0.8 ± 15.7	−0.4 ± 16.6	.774

w, weighted radiographs; *nw*, non-weighted radiographs; *CCD*, coracoclavicular distance; *IS*, injured side; *HS*, healthy side; *Cla*, clavicle; *Cor*, coracoid.

Table IV
Radiological measurements of 29 patients, who had weighted as well as non-weighted radiographs.

w vs. nw			
Measurement	Weighted	Non-weighted	*P* value
Total n	29	29	-
CCD IS (mm)	17.6 ± 6.7	15.8 ± 5.5	.003
CCD HS (mm)	9.2 ± 1.8	8.9 ± 1.9	.313
CCD difference (mm)	8.4 ± 5.1	6.9 ± 5.3	.008
ΔCCD (%)	93.7 ± 57.0	82.7 ± 62.7	.163
Cla-angle (°)	176.2 ± 7.0	179.2 ± 5.9	.002
Cor-angle (°)	179.3 ± 7.1	179.2 ± 5.9	.006
ΔCla (mm)	10.1 ± 18.3	2.2 ± 15.3	.001
ΔCor (mm)	2.3 ± 18.8	−4.1 ± 14.4	.005

w, weighted radiographs; *nw*, non-weighted radiographs; *CCD*, coracoclavicular distance; *IS*, injured side; *HS*, healthy side; *Cla*, clavicle; *Cor*, coracoid.

Table V
Changes of Rockwood classification and type of elevation/depression depending on non-weighted or weighted views.

	Non-weighted	Weighted	Number of cases
Rockwood	II	III	6
	V	III	5
	III	V	2
Type of elevation/depression	A	E	3
	D	E	2
	C	A	2
	B	D	1
	D	B	1
	A	D	1
	D	C	1

strengthening diagnostic accuracy.[19,22] However, taking into account radiation exposure, selective radiographs of the two ACJs, excluding the superior thoracic aperture, should have been obtained as an alternative diagnostic routine to the panorama views.[24]

This study has several limitations. First, the measurements could be inaccurate due to scaling issues, since the radiographs were not supported with a reference sphere. Moreover, the measurements could be affected by the interindividual differences in the three-dimensional morphology of the ACJ.[6] However, the measurements were conducted in a side-comparative standardized fashion, allowing the comparison of measurements inside the same radiograph and eliminating these limitation factors. Second, since our radiological evaluation was accomplished based on the vertical body axis, conditions altering this axis like posture type, scapulothoracic orientation, and scoliosis could have affected our measurements. Third, there is a significant difference in terms of pain in the different moments of the time interval defined as "acute" (≤3 weeks): The pain right after the trauma is significantly more severe than the pain some time later in the post-traumatic setting, accentuating the possible influence of the difference in pain severity on the CCD. Unfortunately, we could not find out with our study, how far the classifications might have been different with or without the pain-triggered muscle contraction. Fourth, the cohort with 29 patients, who had not only weighted but also non-weighted radiographs, contains only small patient numbers and they should not have at first exposed to radiation twice due to radiation hygiene considerations.

Conclusion

Acute injury to the ACJ does not exclusively lead to a depression of the scapula or an elevated distal clavicle but rather leads to various vertical displacement combinations. Regardless of radiological imaging modality (weighted or non-weighted), the most common type was the elevation of both structures, distal clavicle and scapula possibly due to muscle spasm and pain. The routine use of weighted views should be questioned since they might understate or overstate the Rockwood stage leading to inadequate conservative therapy or unnecessary surgical treatment. At the end, the same standardized fashion should be used for all acute ACJ dislocations regardless of the radiological imaging modality.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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